EXHIBIT A

Bruce M. Sass **Battelle**

Senior Research Scientist

Qualifications

Dr. Sass has more than 16 years research experience in chemical, materials science, and environmental science fields. He is an adept problem solver with extensive experience evaluating chemical processes, developing specialized analytical techniques to characterize materials, modeling chemical reactions, and conducting hydrothermal tests. He is well acquainted with analytical and parametric methods for estimating properties of pure materials and mixtures, and conducting phase equilibrium calculations. In addition, Dr. Sass has performed numerous column tests using real-time instrumentation to detect changes in fluid properties. He has in-depth knowledge of thermodynamic principles with emphasis on materials science applications. He has performed extensive work with surface analysis techniques for characterization of minerals, ceramics, ferrous and non-ferrous alloys, using state-of-the-art spectroscopic techniques (SEM, EPMA, XRD, FTIR, ESCA, and EXAFS). Dr. Sass has significant experience developing novel environmental remediation technologies through his work with industrial and government clients. Special interest remediation approaches include: oxidative and reductive pathways for sequestering metals and degrading hazardous chlorinated compounds; surface modification of materials to enhance adsorption coefficients; separation of carbon dioxide from flue gas and geologic sequestration of CO_2 to mitigate global climate change. Secret-level DoD security clearance.

Education

B.S., Geology, State University of New York at Binghamton (1981)
M.S., Geochemistry, Washington State University (1984)
Ph.D., Physical Chemistry, University of Pennsylvania (1991)

Supplementary Training Classes

Separation Processes: Performance, Selection and Scale-Up, American Institute of Chemical Engineers, Course No. 246
Mathematical Modeling and Optimization of Chemical Processes, American Institute of Chemical Engineers, Course No. 003
Geochemical Modeling, U.S. Geological Survey
Groundwater Pollution and Hydrology, Princeton Groundwater
Introduction to the C++ Programming Language, Ohio State University

Project Management Experience

Projects Involving Chromium Contaminated Sites

Buried Chromite Ore Process Residue. Led a scientific investigation for Honeywell International, Inc. to determine the fundamental causes for expansion of chromite ore processing residue (COPR). Investigated mineralogical changes that take place in buried COPR due to hydration of mineral phases that were produced during ore processing and determined how these hydration reactions control expansion. Performed detailed characterization of the client's material using state-of-the-art imaging and spectroscopic techniques, including optical and

scanning electron microscopy (SEM), electron probe microanalysis (EPMA) and x-ray diffraction (XRD) with quantitative whole pattern fitting (Rietveld) technique. Developed a reaction path computer model to simulate hydration reactions and make predictions about the evolving mineral makeup of COPR, which included estimating volume changes due to mineral transformations that can lead to expansion. Performed a statistical analysis based on mineral, chemical and cone penetrometer data to better understand the spatial variability and evolution of localized lithification of COPR.

RCRA Closure Plan for Potential Release of Hexavalent Chromium at Navy BRAC Site. Project manager for Naval Facilities Engineering Command task to perform groundwater monitoring at Former Long Beach Naval Shipyard to achieve RCRA closure of a hazardous waste storage site and permit property transfer of the former Base to the Port of Long Beach. Developed a geochemical model showing that the groundwater chemistry at the facility is conducive for the reduction of hexavalent chromium to trivalent chromium, causing migration of Cr(VI) in the groundwater to be extremely limited under such conditions. Developed a sampling strategy based utilizing new and existing wells in the vicinity of the site to assess any Cr(VI) impacts to the groundwater and/or to monitor any attenuation of the Cr(VI) concentrations. Prepared a work plan, sampling and analysis plan, and site health and safety plan for the monitoring effort.

Chromium Investigation at Wood Pulping Facility. Evaluated causes of high concentrations of reduced chromium at a former wood pulping facility for an industrial client. Assessments included characterization of lignosulfonate that had leaked from storage tanks and commingled with hexavalent chromium. Designed analysis plan for evaluating lignosulfonate structure and mechanism for chelation of chrome. Developed treatability studies evaluating remediation options including advanced oxidation technologies followed by reduction and precipitation of chrome (III) hydroxide.

Evaluation of Chromium Oxidation and Reduction in Drinking Water. Project manager for U.S. EPA study to evaluate in a laboratory setting how extensively chlorine oxidizes trivalent chromium to the hexavalent form, with and without the presence of typical drinking water treatment coagulants (i.e., alum and ferric). Similarly, evaluated how extensively stannous chloride can reduce Cr(VI) to Cr(III) with and without drinking water treatment coagulants. A Quality Assurance Project Plan (QAPP) was developed and implemented to serve as the guideline for carrying out laboratory activities. Prepared a report summarizing the data generated by the laboratory study.

Projects Involving Carbon Management for Mitigation of Climate Change

Geochemistry Investigation for Geologic Sequestration of CO_2 in Deep Sedimentary Basins. Assessed the long-term behavior and storage of CO_2 by detailed geochemical characterization of in-situ formation fluids. A 9,190 ft–deep well was drilled to evaluate the CO_2 storage potential of the entire sedimentary sequence in the Appalachian Basin at the American Electric Power (AEP) Mountaineer Plant in New Haven, West Virginia. The AEP borehole characterization program included the following elements: detailed hydrochemical sampling of brine (obtained from two sandstone formations, Rose Run and the basal sandstone), a comprehensive suite of geophysical wireline logging, core analysis, and reservoir hydrologic testing. Used stable isotope ratios and other hydrochemical measurements to show that the candidate storage formations at the AEP borehole are similar geochemically to other deep formations in the region and are isolated from overlying surface and groundwater. Geochemical modeling results indicated no adverse reactions on potential injection of CO_2 into either of the candidate storage formations (Rose Run and basal sandstone). This work was conducted under the Ohio River Valley CO_2 Storage Project, funded

by U.S. Department of Energy, American Electric Power, BP, The Ohio Coal Development Office, Schlumberger, Battelle, and Pacific Northwest National Laboratory.

Regional Carbon Sequestration Program. Overseeing CO_2 sourcing and transport aspects of Battelle's carbon sequestration program for the Department of Energy's Midwest Regional Carbon Sequestration Partnership (MRCSP). This program was formed in 2003 to develop solutions that will help reduce CO_2 emissions while simultaneously protecting the industrial economy of the Midwest. Led by Battelle, MRCSP's mission is to map and define the sequestration potential of the Region, as well as understand key regulatory issues and a first-ever systematic attempt to engage and inform stakeholders about this important class of technologies.

Geologic Sequestration of Carbon Dioxide. Led experimental program for Battelle to assess the feasibility of geologic sequestration of carbon dioxide. Responsible for conducting high-pressure autoclave experiments and running computer models to investigate the fate of injected CO_2 in deep saline formations. Currently deputy project manager on a $4.1 M project funded by DOE's National Energy Technology Laboratory, the Ohio Coal Development Office, and several industry partners. Results of this work have been presented at four international conferences on global climate change. The overall purpose of the current effort is to demonstrate that large amounts of CO_2 can be stored in the subsurface, safely, and for long periods.

Projects Involving Perchlorate and other Recalcitrant Contaminants in Groundwater/Drinking Water

Migration of Perchlorate in Groundwater at NASA-JPL. Developed geochemical model to evaluate groundwater chemistry for the Jet Propulsion Laboratory (JPL) site in Pasadena, California. Used groundwater chemistry data combined with the stable isotope analyses to improve the understanding of groundwater flow conditions within the sub-basin surrounding Pasadena. Used stable isotope analyses to evaluate the fate and transport of perchlorate-containing groundwater originating from the JPL site. Analyses used in this study include perchlorate isotopes ($\delta^{35}Cl$, $\delta^{18}O$, $\delta^{17}O$ and $\Delta^{17}O$), groundwater isotopes ($\delta^{18}O$ and $\delta^{2}H$), strontium ($^{87}Sr/^{86}Sr$), tritium dating ($^{3}H/^{3}He$), and several geochemical parameters.

Permeable Reactive Barriers. Led multiple laboratory and field investigations to understand the effects of groundwater geochemistry on the performance and longevity of permeable reactive barriers for degrading chlorinated organic compounds (TCE, *cis*-DCE). Applied expertise in mineral phase behavior, thermodynamic modeling, and surface analysis to develop a comprehensive assessment on the impact of corrosion products on electron transfer efficiency. Co-wrote two guidance documents and a book for the application of permeable barriers to groundwater remediation.

Contaminant Immobilization Barrier. Directed Battelle-sponsored R&D effort to investigate use of organic cations to sorb contaminants onto soil particles. Tests in the laboratory have shown excellent performance for immobilizing MTBE, TCE, and energetic substances (TNT, HMX, and RDX) in a native California soil and pure clay mineral. Results of this project showed that sorption of contaminants can be enhanced by treating soils with small concentrations of sorbing agents. Two application modes are being considered: spraying onto surface soils to immobilize contaminants in the top few inches of the soil zone and prevent migration to groundwater and surface water; and injecting into a contaminated aquifer in advance of the plume, causing the contaminants to be trapped inside the permeable immobilization barrier.

Evaluation of Arsenic Compounds in Drinking Water Distribution Lines. Managed investigation of U.S. EPA project to investigate arsenic in absorbent media and pipeline transport components. Employed advanced spectroscopic techniques, including XPS, for determining

compositions and oxidation states of arsenic in drinking water distribution systems, including main distribution lines, pipes, and fittings.

Projects Involving Contaminated Sediments

Characterization of Contaminant Transport Potential Through In-Place Sediment Caps. Co-principal investigator for SERDP-sponsored project to develop and improve engineering tools for more cost effective and efficient cap designs by enhancing the scientific understanding of contaminant transport through sediment caps and the contributions of bioturbation, pore water advection, and sorption. The study uses innovative field and laboratory tools, analytical techniques, and numerical modeling to build on the current knowledge of contaminant transport through caps. Specific goals are to examine contaminant transport over time at two existing capped sites and to quantify aqueous contaminant transport and the processes that govern contaminant transport. This is accomplished by measuring pore water advection, contaminant concentration profiles over time, and laboratory measurements of contaminant transport processes. Both conventional and innovative cap materials are being investigated.

Upland Disposal of Dredged Sediment. Dredged sediment from Mill Creek, a large urban drainage stream in Hamilton County, Ohio, was collected for a U.S. EPA study on beneficial use in an upland setting. A laboratory study was conducted to investigate the effect of admixing a chemical amendment (blast furnace slag) with a fresh-water sediment on reducing metal availability. A series of characterization, leaching, and plant availability testing methods indicated that the amendment of the sediment with blast furnace slag (4% on a dry weight ratio basis) had the potential to reduce the availability of certain hazardous metals.

Leachability of Metals from Sediments in a Confined Disposal Facility. Dredged sediment was obtained from Hart-Miller Island, at the western shore of a Chesapeake Bay Confined Disposal Facility (CDF). This study was conducted for U.S. EPA to evaluate sediment leaching in an active CDF with and without an amendment admixture, to determine changes in metal availability. Results of laboratory experiments show that leachate losses can be minimized by modifying chemical conditions in the sediment zone and using operational practices such as recirculating the leachate to maintain reducing conditions, manipulating pH to minimize solubility, or adding a physical sorbent to sequester heavy metals.

Sediment Characterization Guidance Document. Prepared a guidance document on Rapid Sediment Characterization (RSC) tools for SPAWAR that describes operation of real-time screening methods for delineating the extent of contamination and physical characteristics and biological effects of contaminants in marine sediment. The analysis methods included x-ray fluorescence spectrometry, ultraviolet fluorescence spectrometry, immunoassay, and bioluminescence. Developed Standard Operating Procedures, Scope of Work template and Cost Estimating Spreadsheet for using commercially available instruments. Incorporated three detailed case studies that describe the use of RSC tools and practices within the Navy. Also, conducted an external market survey to assess usage of RSC tools by Navy contractors.

Investigation of Vapor Transport at Contaminated NAPL Site. Assessed groundwater and soil gas data at the Marine Corps Air Ground Combat Center in Twentynine Palms, California, where leakage of gasoline from former underground storage tanks (USTs) resulted in soil and groundwater contamination beneath the site. Barometric and soil gas pressure measurements were used to show the effect of barometric pumping on advective flow of gasoline vapor in the unsaturated soil. Computer modeling using a multiphase transport code was used to provide the source term for hydrocarbon contaminants in a groundwater intrinsic remediation model.

Projects Involving Pollution Prevention Technologies

Novel Gas Phase Separation Device. Led effort to develop an advanced gas phase separation technology. Coordinated an internally funded R&D study to investigate the performance of an enhanced CO_2 scrubber using a novel gas-liquid contactor designed at Battelle. Other applications are being evaluated for pharmaceutical and chemical processing industries. Obtained U.S. patent for this process.

Demonstration Evaluation of Biodegradable Degreaser to Replace Solvents. Project manager for EPA project to evaluate a biodegradable degreaser as a potential substitute for conventional alkaline cleaners and chlorinated cleaning solvents. Battelle is conducting the evaluation under contract agreement with the National Risk Management Research Laboratory (NRMRL) of the United States Environmental Protection Agency (U.S. EPA). The approach is to work with industry to provide technical and economic information about new technologies for potential users so that they can achieve voluntary reductions in the use and release of hazardous substances. The intent of EPA's approach is to encourage the use of less polluting substances in industrial operations.

Active Noise Cancellation. Project manager for U.S. Navy contract to develop an active noise cancellation (ANC) system to reduce excessive sound levels at Submarine Dry Dock operations in Silverdale, WA. The technology was demonstrated on a commonly deployed exhaust fan that was determined to have excessive sound levels in and around the dry dock during typical refit operations. The first phase of this project utilizes a Coppus TM-8 fan for developing the ANC methodology, ANC algorithms, feedback approach, electronics, reference microphone, error-sensing microphone, and loudspeakers. The objective is to demonstrate the exhaust noise reduction that is feasible with the ANC approach with practical hardware and field grade components. In a follow-on phase, Battelle designed a field-hardened system installed on the Coppus fan and delivered the unit for dry dock evaluations. The delivered unit met safety and operational environment requirements necessary for use in the submarine dry dock environment.

Pollution Prevention Program Manager. Project manager for a $15M, 5-year Pollution Prevention (P2) task order contract with the Naval Facilities Engineering Service Center (NFESC). Battelle is a subcontractor to Santa Barbara Applied Research, Inc. (SBAR), a privately held small disadvantaged business in California. The scope of the P2 contract encompasses support in the form of personnel, equipment, materials, and facilities to respond to the Navy's environmental needs under multiple tasks. Work includes a wide range of engineering services and construction efforts related to pollution prevention and remedial measures.

Internet Training Course Development. Assisted the Interstate Technology and Regulatory Cooperation (ITRC) in conjunction with the EPA Technology Innovation Office in developing basic and advanced internet training courses for Permeable Reactive Barriers. ITRC Internet Training has reached over 8000 participants since mid-1999 throughout the United States and around the world.

Transport and Reaction Modeling in Flue Gas Venting Systems. Task leader for a modeling study involving transport and chemical reactions in venting systems for natural gas-operated appliances. This project for the Gas Research Institute (GRI) investigated enhanced corrosion of metal substrates due to acid attack by CO_2, SO_x, and NO_x.

Supercritical CO_2 for Precision Cleaning. Principal Investigator of cosponsored U.S. EPA and U.S. Navy demonstration study to investigate the feasibility of replacing Freon™ and other halogenated solvents with supercritical CO_2 for precision cleaning applications. A Category III Quality Assurance Project Plan was written for this study. Conducted experiments to determine, solubilities of aerospace lubricants, surface adsorption on steel substrates, and compatibility with polymers. Measured surface contamination by grazing angle Fourier Transform Infrared Spectroscopy (FTIR) and X-Ray Photoelectron Spectroscopy (XPS).

CO_2 Snow Decontamination of Miniature Electrical Contact Switches. Developed fixture to rapidly remove dust and other particulate from miniature contact switches during assembly operation. Process uses CO_2 snow (dry ice) blasting to displace contaminants. Conducted laboratory tests to determine cleaning efficiency based on particulate removal. Characterized residue by optical imaging methods.

Evaluation of Alternative Test Fluids for Automotive Industry. Conducted a survey of fluid properties for a U.S. automaker to identify alternatives to gasoline for calibrating fuel injection systems. Selections were made to include only feasible alternatives from a technical standpoint. The final set of selection criteria focused on fluids that were considered good matches for the fluid properties of unleaded gasoline, can be obtained in commercial quantities, and would be acceptable based on health, safety, and plant operation considerations.

Replacements for Mercury in the Electronics Industry. Principal Investigator of U.S. EPA-sponsored study to evaluate mercury replacement technologies in selected electronics industries. Showed how trends in the electronics industry affect the U.S. mercury market, contribute to municipal and hazardous solid waste disposal, affect the development of replacement technologies, and possibly promote other forms of pollution as a result of adopting the replacement technologies.

Patents and IP Records

Lead inventor on patent for "Improved Method of Separating Carbon Dioxide From a Gas Mixture Using a Fluid Dynamic Instability." US Patent 6,582,498. June 24, 2003.

Battelle IP Record (#12628, 4/27/2000) "Carbon Dioxide Separation From Flue Gases By A Unique Fluid Dynamic Instability Approach."

Battelle IP Record (#13193, 7/5/2001) "Immobilization of MTBE in Aquifers Using Surfactant-Modification."

Awards, Accomplishments, and Recognition

- Serving on Steering Committee for the U.S. EPA-sponsored Remediation Technologies Development Forum (RTDF), Permeable Reactive Barrier Action Team (1999-present).
- Steering committee member, short course instructor, and organizational planner for Battelle's *International Conference on Chlorinated and Recalcitrant Compounds*, held in Monterey, CA.
- Recipient of Battelle Key Contributor Award for winning a DOE carbon management contract.
- Maintains up to date understanding of chemical systems through short courses offered by the American Institute of Chemical Engineers and other professional organizations.
- Patent pending on novel gas-liquid contactor for separation of gas components from a mixture.
- Lead inventor of several Intellectual Property Records.

Professional Society Membership

American Chemical Society
American Institute of Chemical Engineers
Geochemical Society of America

Publications and Presentations

Sass, B.M, D.T. Kremser, G.I. Clark, and C. French. 2005. "Hydration-Induced Expansion of Chromite Ore Processing Residue." Presentation at the *Eighth International In Situ and On-Site Bioremediation Symposium*, June 6-9, 2005, Baltimore, MD.

Kremser, D.T., B.M. Sass, G.I. Clark, M. Bhargava and C. French. 2005. "Environmental Forensics Investigation of Buried Chromite Ore Processing Residue." Paper and presentation at the *Eighth International In Situ and On-Site Bioremediation Symposium*, June 6-9, 2005, Baltimore, MD.

Sass, B, S. Chattopadhyay and E. Barth. 2003. "Leachability Studies of Trace Metals From Dredged Sediments." *International Conference on Remediation of Contaminated Sediments,* Venice, Italy, 30 September – 03 October.

Sass, B.M., N. Gupta, S. Chattopadhyay, J. Ickes, and C.W. Byrer. 2003. "Evaluation of CO_2 Sequestration in Saline Formations Based on Geochemical Experiments and Modeling." *Proceedings of the Sixth International Conference on Greenhouse Gas Control Technologies, Kyoto, Japan, October 1–4, 2002.*

Gupta, N., B. Sass, S. Chattopadhyay, J. Sminchak, P. Wang, and T. Espy. 2003. "Geologic Storage of CO_2 from Refining and Chemical Facilities in the Midwestern United States." *Proceedings of the Sixth International Conference on Greenhouse Gas Control Technologies, Kyoto, Japan, October 1–4, 2002.*

Gupta, N., L. Smith, B. Sass, and C. Byrer. 2003. "Engineering and Economic Assessment of CO_2 Sequestration in Saline Aquifers." *Proceedings of the Sixth International Conference on Greenhouse Gas Control Technologies, Kyoto, Japan, October 1–4, 2002.*

Sass, B., A. Gavaskar, W-S. Yoon, E. Drescher and C. Reeter. 2002. "Geochemical Factors Affecting Performance and Longevity of Permeable Reactive Barriers." *Proceedings of the Third International Conference on Remediation of Chlorinated and Recalcitrant Compounds.* Monterey, California, May 20–23.

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Chattopadhyay, S., B. Sass, and J. Sorg. 2002. "Immobilization of MTBE with Organo-Modified Soils." Proceedings of the *Third International Conference on Remediation of Chlorinated and Recalcitrant Compounds*, Monterey, CA, May 20-23.

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Gupta, N., L. Smith, B. Sass, and J. Sminchak. 2001. "Engineering and Economic Assessment of Carbon Dioxide Sequestration in Saline Formations." *Proceedings of the First National Conference on Carbon Sequestration.* Washington DC. May 15-17.

Sminchak, J., N. Gupta, and B. Sass. 2001. "Issues Related to Seismic Activity Induced by the Injection of CO_2 in Deep Saline Aquifers." *Proceedings of the First National Conference on Carbon Sequestration.* Washington DC. May 15-17.

McGrail, B.P., K.P. Saripalli, B. Sass. 2001. "Use of Alkaline Waste Matrices for Sequestration of CO_2." *Proceedings of the First National Conference on Carbon Sequestration.* Washington DC. May 15-17.

Sass, B., N. Gupta, J. Ickes, P. Bergman, and C. Byrer. 2001. "Experimental Evaluation of Chemical Sequestration of Carbon Dioxide in Deep Saline Formations." *Proceedings of the Fifth International Conference on Greenhouse Gas Control Technologies, Cairns, Australia, August 14-16, 2000.*

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Yabusaki, S., K. Cantrell, B. Sass, and C. Steefel. 2001. "Multicomponent Reactive Transport in an In Situ Zero-Valent Iron Cell." *Envir. Sci. Technol. 35:* 1493-1503.

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Sass, B., N. Gupta, J. Sminchak, and P. Bergman. 1999. "Geochemical Modeling to Assess the Capacity of a Midwestern United States Geologic Formation for CO_2 Sequestration." *Proceedings of Fourth International Conference on Greenhouse Gas Control Technologies, Interlaken, Switzerland, August 30 – September 2, 1998.*

Sass, B., N. Gupta, L. Smith, and E. Drescher. 1999. "Experimental Evaluation of Chemical Sequestration of Carbon Dioxide in Deep Saline Formations." Phase I Topical Report. Battelle report prepared for U.S. Department of Energy, Federal Energy Technology Center, Contract No.: DE-AC26-98FT40418. February 9.

Gupta, N. and B. Sass. 1999. "Hydrodynamic and Geochemical Modeling for Carbon Dioxide Sequestration in Deep Saline Formations." Battelle report prepared for U.S. Department of Energy, Federal Energy Technology Center, Contract No.: DE-AF26-98FT00874.

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Gavaskar, A., Gupta, N., Sass, B. M., Fox, T., Janosy, R., Cantrell, K., Olfenbuttel, R. 1997. *Design Guidance for Application of Permeable Barriers to Remediate Dissolved Chlorinated Solvents.* February 28.

Gupta, N., F. Herlihy, and B. Sass. 1997. *Feasibility of Underground Carbon Dioxide Injection in the Midwest: A Literature Review*. Battelle report prepared for U.S. Department of Energy, Pittsburgh Energy Technology Center, Contract No. DE-AF22-96PC1006.

Gavaskar, A., B. M. Sass, N. Gupta. 1996. *Draft Performance Monitoring Plan for a Pilot-Scale Permeable Barrier at Moffett Federal Airfield in Mountain View California.* December 9.

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Sass, B. M., and D. Rai. 1987. "Solubility of Amorphous Chromium (III)-Iron (III) Hydroxide Solid Solutions." *Inorganic Chemistry, 26*:2228-2232.

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